The Reflex Machine and the Cybernetic Brain

The Reflex Machine and the Cybernetic Brain:
The Critique of Abstraction and its Application to Computationalism

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Abstract

Objections to the computational theory of cognition, inspired by 20th century phenomenology, have tended to fixate on the embodiment and embeddedness of intelligence. In this paper I reconstruct a line of argument that focusses primarily on the abstract nature of scientific models, of which computational models of the brain are one sort. I observe that the critique of scientific abstraction was rather commonplace in the philosophy of the 1920's and 30's and that attention to it aids the reading of *The Organism* (1934/1939) by the neurologist Kurt Goldstein. With this background in place, we see that some brief but spirited criticisms of cybernetics by two later thinkers much influenced by Goldstein, Georges Canguilhem (1963) and Maurice Merleau-Ponty (1961), show continuity with the earlier discussions of abstraction in science.

1. Why the Brain is Not a Computer: Two Kinds of Argument

The much publicised successes of artificial intelligence today – artificial neural networks that understand human speech, recognise faces, and defeat the best humans at the game Go – are generating speculation about the prospect of "solving intelligence", the creation of a general, human level artificial intelligence. In the background of such forecasts is the assumption of *computationalism*. By this I mean the idea that the essence of cognition

(defined broadly to include perception, emotion, motor coordination) is computation. According to computationalism, cognition in a living animal can in principle be fully described, explained, and replicated by discovery of the computations employed in its tissues -- principally, in its brain and nervous system.

In an earlier wave of hype around AI, a counter-movement of philosophical arguments against computationalism sprang up, giving us the memorable thought experiments of the "Chinese Room" and "Blockhead."[1] One current of anti-computationalist thought, associated in particular with the work of Hubert Dreyfus (1972), presented itself as speaking for the phenomenological tradition of early and mid 20th century philosophy. This current gave us the *embodiment* / *embeddedness* argument against computationalism. To put things very briefly, the idea is that there is an inarticulable background to intelligence, an *embodied* capacity to cope and act in the environment to which the creature is adapted (in which it is *embedded*), that is an essential precondition for intelligence, but which cannot be articulated and written into computer code. Since this background of coping skills cannot be programmed into artificial devices, but an agent cannot be truly intelligent without it, artificial intelligence (at least of the "symbolic" sort reliant on coded instructions) is impossible. This kind of anti-computationalist argument received much attention and helped start a movement of research within robotics, philosophy and cognitive science, often known as the 4E programme, standing for *embodied, embedded, ecological* and *enactive* cognition.[2]

In this paper I make the case that there is another line of argument against computationalism -- the *abstraction argument*[3] -- that can be re-constructed from early-to-

[1] Searle (1980) and Block (1981). I will not be discussing these arguments further.

[2] Dreyfus (2008) presents some criticisms of this programme as carried out in robotics.

[3] In today's philosophy of science, the treatment of *abstraction* (simplification, the omission of details) in scientific representation is often paired with *idealisation* (the employment of 'distortions,' 'fictions' or ideal mathematical structures that do not appear in nature). Since the omission of details is itself a kind of distortion, it can be hard to see the difference between abstraction and idealisation -- other than abstraction

mid 20th century philosophy, and which has been unduly neglected. The abstraction argument is a contribution to the philosophy of cognitive science, rather than a claim from within the philosophy of mind about the nature of cognition itself. The idea is just that scientific theories and models are always generated via abstraction from the greater complexity of concrete systems in nature. Thus, a computational model of the brain (or of just one of the brain's functions) will be a very abbreviated abstraction and will leave out the details of the organismic processes which are actually responsible for sentience and flexible intelligence. For this reason, superficial appearances of equivalences of functions, between animals and computers, for narrowly specified behaviours, should not be taken as evidence that the computer model has captured something of the essence of organic intelligence, and that more elaborate versions of such models will scale up to replicating the total cognitive capacities of a living animal.

Adherents to the 4E programme make the ontological claim that mind is embedded and embodied, but tend to neglect the examination of scientific methodology that is foundational to this claim about the nature of mind. The purpose of this paper is to examine this neglected philosophy of science. In broad strokes, my view of the relationship between these two kinds arguments against computationalism is as follows. Firstly, that there is a outlook in *general* philosophy of science, which I will dub *the critique of abstraction* in the next section. The critique of abstraction warns us against the reification of abstractions posited by scientists, because although instrumentally and predictively effective, the abstract concepts, and models that employ them, do not reveal the true nature of the objects and systems so depicted. This general stance then has applications in the examination of different branches of science. In philosophy of physics we encounter

being a species of the more general kind, idealisation. But note that the antonym of 'abstract' is 'concrete,' whereas the antonym of 'ideal' is 'real.' Early 20th century accounts of abstraction and idealisation tended to observe a difference between these two scientific practices, by keeping these antonyms in mind: to abstract is to depart from the concrete in a scientific representation, selecting only a few details to feature in the representation; but to idealise is to refer a pattern or tendency present in the real system to a more perfect, ideal version of it that exists only in the scientific representation.

Bergson's rejection of the spatialisation of time (Section 2.1) and Whitehead's warning against the "fallacy of misplaced concreteness" (Section 2.2). It is certainly there in the philosophical background of Gestalt psychology (Harrington 1996, chapter 4).[4]

The critique of abstraction, applied to the science of living systems, is the starting point for Kurt Goldstein's organicist philosophy of biology (Section 3). In fact, the history of the abstraction argument against computationalism is bound up with the early 20th century movement in biology known as *organicism.*[5] Organismic biology is typically contrasted with the mechanistic or reductive approach to living systems, where it is claimed that the reductive, part-to-whole direction of explanation is not adequate in biology, because in living organisms, unlike machines, there is an influence going from the direction of the whole to its constituent parts. For this reason, organismic biology is often referred to as *holistic,* and we find the terms "organism" and "holism" appearing in close sequence, as in the English title of the magnum opus of the neurologist Kurt Goldstein (1878-1965): *The Organism: A holistic approach to biology derived from pathological data in man.*[6] However, claims that the state of the whole organism influences the behaviour of its constituent parts, that organisation matters more in biology than in the physical sciences,[7] and that there are emergent properties, are often taken to be philosophically opaque or problematic because

[4] Length limitations do not permit me to delve into the critique of abstraction as it played out in Gestalt psychology, though obviously this was an important influence on two of the thinkers under discussion here – Goldstein and Merleau-Ponty. It is important keep in mind that they were not uncritical adherents to Gestalt ideas (Goldstein 1934/1939, chapter 8, Muller 2018) .

[5] See Peterson (2016, 6-7) who quotes Ritter's definition of organicism as resting on, "the belief that a whole organism is '*as essential to an explanation of its elements as its elements are to an explanation of the organism*'" (emphasis original); also Dupré and Nicholson (2018).

[6] The original title is: *Der Aufbau des Organismus: Einführung in die Biologie unter besonderer Berücksichtigung der Erfahrungen am kranken Menschen.* See Harrington (1996, chapter 5) for an overview of Goldstein's life and work; also Ferrario and Corsi (2013).

[7] E.g. Goldstein (1934/1939, 421-2): "This 'essence of nature' cannot be dissected mechanistically into parts, but it is a structurally articulated organization. True, we can dismember it, so that we construe 'parts'; but this is only the case when we actually take it apart, i.e. split it up into its physico-chemical elements."

even though organicists eschew metaphysical vitalism (i.e. commitment to special vital forces or substances), the ontological status of the "whole", "organisation" and "emergence" is left under-theorised (Wolfe 2014). Below, I aim to show how the examination of the abstraction argument helps ground a more charitable interpretation of organicism, by helping to differentiate it from metaphysical vitalism.

My claim is that the critique of abstraction employed in the philosophy of cognitive science leads inevitably to an anti-computationalist stance, in which computational models are at best predictively useful devices, and at worst generate the mistaken idea that cognition essentially *is* computation. With this view in place, a natural corollary in the philosophy of mind is the thesis that the cognition is a process that is essentially embodied and embedded – as upheld by the 4E movement. Examining historical precursors of the 4E movement – Merleau-Ponty, and Goldstein before him, we see that the critique of abstraction is foundational to the view that mind is embodied and embedded. That is, we see that the claims for embodiment and embeddedness are more compelling when resting on the foundation of the general philosophy of science that is the critique of abstraction. My account will come with some criticism of the way that Merleau-Ponty has been read in the 4E tradition. Similar to Matherne (2014), I suggest that the level of attention paid to embodiment in Merleau-Ponty has occluded recognition of other dimensions of his thought. My account recommends a decentring of the *Phenomenology of Perception*, or at least an effort to pay more attention to works in which the detailed and critical examination of scientific methodology -- modelling and experimental practice -- is more prominent. It also pays to compare Merleau-Ponty's views on abstraction in science to those of a contemporary not (to my knowledge) cited in the 4E literature – the historian and philosopher of science Georges Canguilhem. Both read Goldstein closely, and acknowledge their debt to his criticisms of mechanistic reflex physiology.

The paper is arranged in an approximately chronological fashion. In the next section I offer a portrait of the discussion of abstraction in philosophy of science before WWII, with reference in particular to Bergson (1859-1941), Whitehead (1861-1947) and Husserl

(1859-1938). After my reading of Goldstein, which shows how his organicist thought is informed by the critique of abstraction, I demonstrate the continuity between Goldstein's approach to biological knowledge, and the discussions of the machine-organism relationship in Georges Canguilhem (1904-1995) (Section 4) and Maurice Merleau-Ponty (1908-1961) (Section 5). This last philosopher is now strongly associated with the embodiment/embeddedness argument against computationalism. But I will argue that in some key remarks on cybernetics, an early movement in artificial intelligence, the abstraction argument against computationalism plays a primary role. The rejection of the possibility of AI is often taken as a "biochauvinism" and anthropocentrism, which grants special status to cognition in living creatures, especially humans, for no sound reason. The focus on abstraction offers a way to interpret the "biochauvinism" of Goldstein and Canguilhem (Wolfe 2015) not as in fact a chauvinism (an un-principled assertion of a difference), but a stance based on a defensible philosophy of scientific experimentation and modelling. The final Section 6 concludes with some proposals for future lines of investigation.

2. The Critique of Abstraction, 1907-1938

The common impression of the development of philosophy of science in the early decades of the twentieth century is a victor's history: the tradition was founded by the "logical positivists" or "logical empiricists" such as Rudolf Carnap and Otto Neurath of the Vienna Circle; exile in the late 1930's brought this tradition of analysis to the USA, where common-sense anglophone realism provided a necessary correction to the Viennese empiricism, and Thomas Kuhn's efforts grounded philosophy of science in real world cases from the history of science. What this story neglects is the important work within other traditions vying for the label "scientific philosophy", phenomenology and the neo-Kantianism of the German-speaking world before WWII (Neuber 2016). Also ignored is the work in philosophy of science of Bergson and Whitehead, two metaphysicians with a strong process orientation. The neglected tradition is anti-positivistic in that it denies that experience offers us neutral facts or observations that provide a foundation for the edifice of scientific knowledge. Attention to the way that the cognitive and material activities of scientists actively shape

the epistemic products of science is not compatible with a crude empiricism or positivism[8] that takes scientific knowledge to be made out of materials passively received from empirical observation, and not ones partially informed by human conditioning. That science relies on idealization and abstraction is an important indication of human-conditioning, the not purely factual nature of scientific knowledge. Thus it is not surprising that discussions of abstraction and idealization are common in the neglected tradition.[9]

The sociologist and phenomenologist Alfred Schutz, writing in 1953, makes a retrospective observation of a consensus opinion – regarding the abstract nature of scientific knowledge – amongst a range of thinkers:

> Most prominent thinkers of our time, and among them philosophers as different as James, Dewey,[10] Bergson, Whitehead, and Husserl, have taught us that all our knowledge of the world in common sense as well as in scientific thinking involves constructs, namely, a set of abstractions, generalizations, formalizations, and idealizations specific to the respective level of thought organization. Strictly speaking, there are no such things as mere facts, pure and simple. All facts are from the outset facts selected from a universal context by the activities of our mind. They are therefore always interpreted facts, namely, either facts looked at as detached from their context

[8] I say "crude" because there are ways for empiricists account for abstraction in science. This is prominent in Ernst Mach's writing (e.g. Mach 1895).

[9] One should note that attention to the active and constructive nature of scientific knowledge is consistent with a Kantian epistemology. It is not coincidental that important early 20th century treatments of idealization in science came from philosophers belonging to a Kantian tradition: Cassirer (1910/1923), Vaihinger (1911/1924). One should also note that the organicist critique of abstraction is prefigured in 19th century German Idealism, especially the work of Schelling and Hegel, (e.g. Hegel 1807/2018, §§281-2); and before then in the organicist materialism of Margaret Cavendish (Peterman 2019). It is also feasible to connect George Berkeley's rejection, in the *New Theory of Vision,* of a proto-version of computationalism – Descartes' geometric theory of distance perception – to the critique of abstraction that pervades Berkeley's philosophy.

[10] For the purposes of this paper I will say little about the place of American pragmatism in the critique of abstraction, focussing instead on the philosophers who had a more obvious influence on the thought of Merleau-Ponty and Canguilhem. The connections between James and Bergson are prominent (e.g. James 1909/1936).

> by an artificial abstraction or as facts considered in their particular setting. In either case, they carry along their interpretational inner and outer horizons. This does not mean that in daily life or in science we are unable to grasp the reality of the world. It just means that we grasp merely certain aspects of it, namely, those which are either relevant to us either for carrying on our business of living or relevant from the point of view of a body of accepted rules of procedure of thinking called the method of science. (Embree 1997, 135)

The context of Schutz's paper is telling. It was a response to papers by Ernst Nagel and Carl Hempel[11] that had been presented at an American Philosophical Association symposium on, "Concept and Theory Formation in the Social Sciences." An exchange of letters between Schutz and the phenomenologist Aaron Gurwitsch indicates that there was at the time a struggle going on for the soul of philosophy of science in America, with positivists and phenomenologists each staking their claims (Embree 124).[12] An indication of the decisive victory of the positivist side is that none of the philosophers on Schutz's list went into the Philosophy of Science canon that was established in the 1960's and after, which was pretty much restricted to logical empiricists, Kuhn, and the anglophone scientific realists who responded to them. Since abstraction and idealization, being indications of the conditioned nature of scientific facts, are a fly in the ointment of the empiricist philosophy of science attacked by Schutz, it is not coincidental that these topics only became prominent again in philosophy of science after the 1980's, when empiricism had by then faded. A key work that put idealization back on the agenda for philosophers of science was *How the Laws of Physics Lie* by Nancy Cartwright (1983). These later discussions of abstraction and idealization do not, however, tend to refer to the early 20th century treatments, the memory of which had by then been consigned to oblivion.[13] For readers

[11] Two philosophers who had a major role in the establishment of the logical empiricist/positivist tradition of philosophy of science in the USA.

[12] See also the dedication of Herbert Spiegelberg (1960), which is to the memory of Alfred Schutz -- "one of the brightest hopes for an authentic phenomenology in the United States".

[13] The exception is Duhem (1906/1954), whom Cartwright credits and who is often discussed in philosophy of science textbooks, though he tends to be assimilated to instrumentalism – a kind of empiricist anti-realism.

unfamiliar with these early views I provide in the remainder of this section a summary of some relevant points from Bergson, Whitehead, and Husserl on the topic of abstraction.

2.1 Bergson on the Primal Abstractions of Modern Science

A running theme of Bergson's philosophy is that the progress of classical physics, and the mechanistic biology based on its principles, came at the expense of a genuine understanding of time, and the processes of nature that take place in time, because of a reliance on the expediency of treating time by analogy with space (see start Section 4). Thus, there is a basic simplifying assumption that founds classical physics and the rest of modern science, the *spatialisation of time.* A central task of philosophy is to learn to apprehend ("intuit") time as we meet it in experience, independently of this abstraction, which is to experience time as "duration" [*durée*]. In my exposition of Bergson I focus on *L'Évolution Créatrice* (*Creative Evolution)*, which was a best seller in its time.

Bergson's account of abstraction in science is bound up with his assumption that the exact sciences are the expression of the human intellect's innate tendencies, which are geared towards the achievement of practical goals rather than knowledge or understanding of nature *per se*.[14] For this reason, we should not expect the results of science to "supply us with an explanation of life" because, "they have something else to do" (Bergson 1907/1944, 25), namely, to enable successful activity in the world. Accurate prediction is a requirement for successful action but, according to Bergson, an intellect bent on prediction will ignore (abstract away from) the manifest differences between individual occurrences of a type of event because they are irrelevant to prediction and the efficiency of a mode of cognition bent on control of nature. Bergson compares the reality of duration with the abstract artifice of the world taken in the intellectual/scientific view, a nature that is predictable because it is presumed to involve absolute repetition:

[14] Examination of the practical intent of human cognition, even when it would seem most theoretical, is a point of connection between Bergson and the American pragmatists.

> Real duration is that duration which gnaws on things and leaves on them the mark of its tooth. If everything is in time, everything changes inwardly, and the same concrete reality never recurs. Repetition is therefore possible only in the abstract: what is repeated is some aspect that our senses, and especially our intellect, have singled out from reality, just because our action, upon which all the effort of our intellect is directed, can move only among repetitions. (Bergson 1907/1944, 52)

Bergson's disagreement with the mechanistic explanation of living systems is that life is essentially temporal,[15] whereas the mechanistic framework is fundamentally atemporal in that the future of the system whose dynamics are to be predicted are entirely given in the initial conditions and equations of motion (p.43).

Generally speaking, Bergson's view of the intellect (and hence science) is that it always proceeds by radical simplification of a natural order that far outstrips human cognitive representations of it with its richness of detail and changeability. Scientific knowledge can be compared with the outcome of simplification via dimensionality reduction. As Bergson writes the intellect, "is only the projection, necessarily on a plane, of a reality that possesses both relief and depth" (1907/1944, 59), and the only way to set aside this narrow and distorted way of seeing the world is to abandon the intellect in favour of a mode of "intuition", less precise but more in tune with the flow of nature. Unlike Whitehead, Bergson does not take there to be flexibility in the kinds of abstractions that science employs, since Bergson takes them to be fixed tendencies of the human intellect. Thus biology is condemned to give us a mechanistic, and hence distorted picture of living organisms, one which analogises them to man-made machines:

> Now I recognize that positive science can and should proceed as if organization [in living bodies] was like making a machine. Only so will it have any hold on organized bodies. For its object is not to show us the essence of things, but to furnish us with the best means of acting on them. Physics and chemistry are well advanced sciences, and living matter lends itself to our action only so far as we can treat it by

[15] As some philosophers of biology would say now, it is essentially *processual* (Dupré and Nicholson 2018).

> the processes of our physics and chemistry. Organization can therefore only be studied scientifically if the organized body has first been likened to a machine…. (Bergson 1907/1944, 103-4)

The mistake, according to Bergson, would be to confuse the outputs of mechanistic biology for the absolute truth about living systems.

2.2 The Fallacy of Misplaced Concreteness

In the widely read *Science and the Modern World*, a collection of lectures delivered in 1925, Whitehead identifies the central task of philosophy as being the criticism of abstractions.[16] The key term of Whitehead's critique is the *fallacy of misplaced concreteness* – which is the error of mistaking the abstractions of science for the concrete things in the world that they are abstractions from. When introducing the fallacy, Whitehead acknowledges his debt to Bergson's writing on the spatialisation of time, but emphasises that he, unlike Bergson, does not think that scientific thought is stuck forever with this problematic abstraction, that it is, "necessary to the intellectual apprehension of nature" (Whitehead 1925/1938, 66).

A central thesis of *Science and the Modern World* is that science since the 17th century (which Whitehead tends to characterise as "Cartesian"), has been conducted under the guiding abstraction of *simple spatial location*. This fosters a crude materialist ontology, mind-matter dualism, and the removal of any intrinsic value from nature, leading to a clash between the scientific worldview and the worldview suggested by ethical and aesthetic experience.[17] Fortunately, Whitehead argues, this guiding abstraction has been shown no

[16] "The disadvantage of exclusive attention to a group of abstractions, however well-founded, is that, by the nature of the case, you have abstracted from the remainder of things. In so far as the excluded things are important in your experience, your modes of thought are not fitted to deal with them. You cannot think without abstractions; accordingly, it is of the utmost importance to be vigilant in critically revising your *modes* of abstraction. It is here that philosophy finds its niche as essential to the healthy progress of society. It is the critic of abstractions" (Whitehead 1925/1938, 74).

[17] E.g. "The two evils [of Cartesian heritage] are: one, the ignoration of the true relation of each organism to its environment; and the other, the habit of ignoring the intrinsic worth of the environment which must be allowed its weight in any consideration of final ends" (Whitehead 1925/1938, 227).

longer tenable by advances in physics (relativity theory and quantum mechanics) and physiology, which together suggest an alternative to materialism, which is *organicism* or *organic mechanism* (see p. 125-9) – a metaphysics which is both *relational* (not assuming the elementary components of the world to be inherently unrelated to one another) and *processual* (not taking there to be changeless elementary components of the world).

As discussed by Dupré and Nicholson (2018) and Peterson (2016), *Science and the Modern World* was an inspirational text for the British group of organicist biologists that included E. S. Russell and J. S. Haldane. There is a reference to Whitehead's book in the list of additional sources in the 1939 English translation of *The Organism,* but it is not clear if Goldstein himself read it. Goldstein's cousin and important philosophical influence, Ernst Cassirer, was well acquainted with the ideas of Bergson and Whitehead, and his *Philosophy of Symbolic Forms* vol. 3 can be read as a response to them, offering a picture of scientific modernity that is rather more sanguine about the abstractions of mathematical physics (Chirimuuta forthcoming-a).

2.3 Abstraction from the Lifeworld

At least two authors of the mid-20th century, reflecting on the recent history of phenomenology, noted a striking convergence in the philosophies of science developed independently by Whitehead and Husserl, which turned on the role of abstraction, in inaugurating a problematic subject-object dualism. Herbert Spiegelberg (1960:78-79) writes:

> There is, in fact, a striking likeness in the diagnosis of this scientific crisis in the nearly simultaneous but independent work of Husserl and Whitehead, although there is no evidence for mutual or one-sided influence: Whitehead, in *The Concept of Nature* (1920) and again in *Science and the Modern World* (1926), found the source of both the grandeurs and miseries of modern science in the 'bifurcation' which it introduced

> between a merely objective and a merely mentalistic or private branch of nature. Similarly Husserl, in his last work on *Die Krisis der europäischen Wissenschaften und die transzendentale Phänomenologie* (1936), blamed the contemporary crisis on the split between Galilean objectivism and Cartesian subjectivism. This does not mean that Whitehead and Husserl also agreed on the therapy. But there is enough in Whitehead's appeal to a return to the realism of immediate 'prehension' as the matrix of all scientific abstractions to make a comparison with some of Husserl's last and particularly fertile ideas appropriate. (Cf. Paci 1961, 1964)

Indeed, the inaugural statement of Husserl's phenomenology, that what is needed is a return to the "things themselves" can be interpreted as a call to depart from the abstractions of the scientific theories of experience and return to the concrete world of lived experience.[18] Goldstein (1971) does list Husserl as one of his three main philosophical influences (alongside Kant and Cassirer). Here Aron Gurwitsch (1901-1973) is an important intermediary figure between Goldstein and Husserl, since he worked both with the neurologist and the philosopher, and later wrote about the correspondences between their ideas (Gurwitsch 1949). I will now examine the critique of abstraction in Husserl.

While the contrast between scientific abstraction and lived experience is an enduring theme of Husserl's work, we have appearing in his late writings, of the 1930's, the key term of the *Lifeworld* [*Lebenswelt*] as the domain of intersubjective experience and practice that both founds scientific activity and is at the same time concealed by the objectifying worldview that science fosters.[19] That science simultaneously pre-supposes and denies or conceals the Lifeworld is an irrationality that is bringing modern science to the point of crisis, according to Husserl; and the task of philosophy is to reveal what is masked by objectifying

[18] "To return to the things themselves is to return to this world prior to knowledge, this world of which knowledge always *speaks*, and this world with regard to which every scientific determination is abstract, signitive, and dependent, just like geography with regard to the landscape where we first learned what a forest, a meadow, or a river is" (Merleau-Ponty 1945/2012, lxxii).

[19] see Moran (2012, chap. 6) and essays in Hyder and Rheinberger (2009) for exposition of the concept of Lifeworld.

science, through an interrogation of the intellectual foundations of science. As he writes of the surrounding life-world:

> it is always presupposed as the ground, as the field of work upon which alone his questions, his methods of thought, make sense. Where is that huge piece of method subjected to critique and clarification [--that method] that leads from the intuitively given surrounding world to the idealization of mathematics and to the interpretation of these idealizations as objective being? (Husserl 1970, 295)[20]

An important idea is that the Lifeworld is itself recalcitrant to the objectivising treatment of natural science, and therefore gets covered with a "garb of ideas" [*Ideenkleid*]. Yet, the Lifeworld is the experienceable world, whereas the objective ("true") world presented by science is an abstraction that is actually not experienceable.

Much of Husserl's discussion centres on the mathematization of nature through the development of quantitative physics beginning with Galileo. A crucial point for Husserl is that the process of abstraction or "formalization" [*Formalisierung*], in which the items of the life world are substituted for geometrised versions, is self-concealing. This is how Dermot Moran (2012:69) explains Husserl's view, noting the agreement with Heidegger on this point:

[20] Also, "Mathenatical natural science is a wonderful technique for making inductions with an efficiency, a degree of probability, a precision, and a computability that were simply unimaginable in earlier times. As an accomplishment it is a triumph of the human spirit. As for the rationality of its methods and theories, however, it is a thoroughly relative one. It even presupposes a fundamental approach that is itself totally lacking in rationality. Since the intuitively given surrounding world, this merely subjective realm, is forgotten in scientific investigation, the working subject is himself forgotten; the scientist does not become a subject of investigation. (Accordingly, from this standpoint, the rationality of the exact sciences is of a piece with the rationality of the Egyptian pyramids.)" (Husserl 1970, 295)

It is worth commenting on the remark in brackets at the end of this quotation. A theme of Husserl's essay is that a distinctively European ideal of rationality, that started in Ancient Greece (marking that culture out from civilisations of the Orient that also had advances in philosophy and mathematics), has been forgotten in modern science. Thus, the comparison of modern science with the Egyptian pyramids is quite loaded and derogatory in the context. See Moran (2011) on the Eurocentrism of Husserl's *Crisis* texts.

> Formalization … abstracts from the material properties of a given entity and focuses on the object in terms of pure, empty, categorical forms…. Logic and mathematics employ formalization. …. Husserl is one of the first to recognize that the 'abstractive closure' (Geschlossenheit…) of the natural sciences is based on an abstraction and formalization away from the concrete individual occurrences. For Husserl (as, indeed, also for Heidegger), modern scientific research involves a particular 'formalization' of experience which should never be substituted for the fullness of that experience itself in its lived 'concretion.'

What is significant for our larger purpose, the reconstruction of an argument against computationalism, is how the critique of abstraction naturally leads one to look back at that which has been abstracted away from in development of the exact sciences, namely, the environing world in which we are embedded and the flesh in which we are embodied. Thus the consideration of embeddedness and embodiedness of human knowing, and cognition more generally, is a natural sequel of the argument from abstraction; but as I will argue below, it is a mistake to take the phenomenological argument against computationalism to be based only on these sequelae and to miss the primary argument from abstraction.[21]

[21] In the lecture notes on *Nature* we can see precisely how Merleau-Ponty interprets Husserl as seeking to interrogate a mode of experience that is prior to the idealized view of things that comes with scientific thought, and how this is said to lead Husserl to an interest in our embodied perceptual experience:

> "consciousness, even reduced, keeps a corner to itself, a fundamental and originary zone on which the world of idealizations is constructed. Kant ignores 'inferior degrees of constitution' – that is, of infrastructures that precede acts of idealization and furnish a quasi-natural base to the development of the *ego cogito* – because what interests Kant at first is the constitution of those idealizations that are science and philosophy. Husserl wants to understand what is nonphilosophical, what is preliminary to science and philosophy: hence his interest in the preliminary work by which a preliminary thing is constituted, and which is of the order of the primordial: hence the description of the role of the body in perception." (Merleau-Ponty 1995/2003, 71)

2.4 The Critique of Abstraction and Organicism

As exemplified by the work of Bergson, Whitehead and Husserl, there was a view prevalent in the interwar period that science provides a set of useful but potentially misleading abstractions. This critique of abstraction forms part of the backdrop to organicist biology.[22] In *Creative Evolution,* there is an early demonstration of how the critique of abstraction synthesises with an anti-mechanistic and holistic philosophy of biology. In answer to the question of whether he is denying that the living body is made up of the same matter as everything else, Bergson gives the reply that,

> we do not question the fundamental identity of inert matter and organized matter. The only question is whether the natural systems which we call living beings must be assimilated to the artificial systems that science cuts out within inert matter, or whether they must not rather be compared to that natural system which is the whole of the universe. That life is a kind of mechanism I cordially agree. But is it the mechanism of parts artificially isolated within the whole of the universe, or is it the mechanism of the real whole? The real whole might well be, we conceive, an indivisible continuity. The systems we cut out within it would, properly speaking, not then be *parts* at all; they would be *partial views* of the whole. And, with these partial views put end to end, you will not make even a beginning of the reconstruction of the whole, any more than, by multiplying photographs of an object in a thousand different aspects, you will reproduce the object itself. So of life and of the physico-chemical phenomena to which you endeavor to reduce it. (Bergson 1907/1944, 36)

[22] One should also mention the "British Emergentists", C. D. Broad and Samuel Alexander, as part of this philosophical context. For example, Broad (1925, 5) writes,

> "The [scientist] tends to forget that he has violently abstracted one part or one aspect of Reality from the rest, and to imagine that the success which this abstraction has given him within a limited field justifies him in taking the principles which hold therein as the whole truth about the whole world."

Though Bergson is often labelled as a vitalist because of his talk of the *élan vital*,[23] we see from this passage that the position is more subtle than this, and in concord with organicism. Bergson does not deny that during experimental investigation the components of a living system can be analysed as physical and chemical processes. What he does query is whether the parts detached in experiment are the 'proper parts' of the system, which are modular or isolatable, as in a machine, or whether we lose something of what the parts are when they are detached from their context because they are, rather, merely "partial views" of the whole system. As we see, this is very similar to Goldstein's complaint that "dissecting" methods of experimental biology (ones which analyse a system part by part) will not be sufficient to explain the operation of the whole organism.

Enzo Paci (1961, 248-50) detects an organicism that is common to Whitehead and Husserl, stemming from their shared view of things in the world as fundamentally interconnected, in which relations have primacy over intrinsic properties. The critique of abstraction and the philosophy of relations together engender an organismic biology: if one considers everything, a forteriori living organisms, to be fundamentally interconnected systems, any approach to knowing them grounded in the investigation of the parts of the systems in isolation, and then subsequent observation of the interaction of parts (as in the reverse engineering of a man-made mechanism), will be an impoverished abstraction, one blind to the ways that contextual factors, the states of the whole system, radically alter the character of the supposed parts. As we will see, the poverty of abstraction is an often sounded note in *The Organism,* and is somewhat dissonant with Goldstein's thesis that abstract thought ("the categorical attitude"), in contrast to behaviour guided only by concrete circumstances, is what is responsible for flexibility and freedom in human actions.

[23] E.g. Peterson (2016: 4-6). Yet, the ontological import of the *élan vital* is not so obvious and Bergson (1907/1944, 48) is careful not to align his philosophy with Hans Driesch and his metaphysics of *entelechies*. See essays in Burwick and Douglass (1992) for more discussion of this question.

3. "Merely Abstractions": Goldstein's Criticism of the Reflex Theory

Roboticists and cyberneticists, the AI developers of recent memory, were not the first to frame the brain within a conceptual scheme inspired by engineering. Before the computational theory of the brain it was common to think of the structures of the nervous system as a reflex machine, an aggregate of discrete sensor and effector arcs, devised by natural selection to orchestrate the adaptive if puppet-like behaviour of humans and other animals. In one seminal presentation of the reflex theory by Thomas Henry Huxley (1875), the workings of the nervous system are compared with a steam engine and a clock, and the first serious proposals to engineer devices to replicate cognitive functions of the nervous system came from the reflex tradition (Hull and Baernstein 1929). By the 1930's the reflex theory in neurophysiology had become a poster child for the mechanistic approach to living systems (Fearing 1930).[24] I should mention in passing that William James (1879, 1890) and John Dewey (1896) were two early critics of the reflex theory, as applied to brain science and psychology. Dewey argued that the cleanly differentiated concepts of stimulus and response, sensory input and motor output are abstractions from what is in reality a continuous circle of activity.

Goldstein makes it clear that his theory of the organism is "diametrically opposed to the usual one, which would regard the lower organisms as reflex machines and which would even reduce the processes in a higher organism to the same mechanical basis" (1934/1939, 171). In this section I will examine in detail Goldstein's criticism of the reflex theory, highlighting the commonalities with the critique of abstraction, discussed above. In the sections that follow, we will see that the arguments against the reflex machine, that turn on a consideration of the limits of knowledge to be gained through scientific abstraction, can be transposed with little effort to make a case against computationalism -- as can be

[24] However, Canguilhem (1955/2015) argues that the concept of the reflex arc did not originate within the mechanistic physiology of Descartes, nor was it developed primarily by mechanists, but belongs to an alternative "vitalist" tradition, from Thomas Willis to Johannes Müller.

seen in the writings of Canguilhem and Merleau-Ponty. It is useful to begin here with Goldstein's response to Charles Scott Sherrington (1857-1952).

On first reading, it is hard to see what the quarrel is between Goldstein and the physiologist whose experimental research was the crowning achievement of the reflex tradition in neurophysiology. Both scientists emphasise that the phenomena of integration and co-ordinated activity are key to understanding the nervous system. Neither believes that the simple reflex – a stereotyped motor response that inevitably follows a specific kind of sensory stimulus, regardless of context – actually occurs in living animals. In a sentence that could have been penned by Goldstein, Sherrington writes near the start of the *Integrative Action of the Nervous System* that,

> A simple reflex is probably a purely abstract conception, because all parts of the nervous system are connected together and no part of it is probably ever capable of reaction without affecting and being affected by various other parts, and it is a system certainly never absolutely at rest. (Sherrington 1906, 7-8)

Most of the text in Chapter 2 of *The Organism* is devoted to showing that empirical observations conflict with the supposition that complex motor responses are combinations of simple reflexes.[25] But Sherrington himself does not commit himself to this unsophisticated supposition; Goldstein in fact grants that Sherrington appreciates "very well that he is dealing with an abstraction" (Goldstein 1934/1939, 89). So why does Goldstein maintain his opposition to this self-aware version of the reflex theory, one that *does not* fall into a fallacy of misplaced concreteness by mistaking the ideal of the simplex reflex for the responses that are actually observable?[26]

[25] Goldstein (1934/1939, 79) summarises: "*Practically nowhere can a simple stimulus response relationship, corresponding to the strict reflex concept, be directly observed.*"

[26] See Merleau-Ponty (1942/1967, 32-33) for a very interesting discussion of Sherrington's appeal to abstraction.

The answer to this question can be found if we consider the sentence of Sherrington's that follows the one quoted above:

> But the simple reflex is a convenient, if not a probable, fiction. Reflexes are of various degrees of complexity, and it is helpful in analyzing complex reflexes to separate from them reflex components which we may consider apart and therefore treat as though they were simple reflexes. (Sherrington 1906, 8)

It is on these points – on the utility of positing these abstractions for the acquisition of knowledge of the system – that the disagreement occurs. For one thing, Sherrington's approach will only work if the reactions that are said to approximate to simple reflexes are really less variable in their manifestations than more complex sequences of behaviours, and Goldstein says that this is not the case (1934/1939, 80). But the deeper point is that Goldstein rejects the utility of deploying experimental interventions to create preparations that approximate to the scientist's ideal of simplicity (such as artificially isolating one part of the system by sectioning the spinal cord), and attempting to work up from the analysis of these isolated, simplified systems to a theory of the whole, integral system. What this methodology assumes is the "summative concept of the whole", the assumption that the behaviour of the whole is equal to the aggregate of the behaviour of its parts examined independently which, according to Goldstein is not adequate to explain how the parts of the organism work together outside of experimental conditions (Goldstein 1934/1939, 90). Alluding to Sherrington, whose most used experimental preparations were the "spinal dog" (Sherrington 1909) and "decerebrated cat", Goldstein observes that physiologists do not notice the inadequacy of summative concept of the whole if they "never deal...with the organism as a whole" (p.90) – if they only make observations of animals whose bodies are mutilated, never studying humans (like Goldstein) or intact animals.

A theme of organicist philosophy, one prominent in the writing of Whitehead, is the criticism of the scientific methodology that seeks to ground knowledge in *substance*, i.e. that which is constant, unchanging, and isolatable, and is taken to underlie the complex, shifting world

of appearances.[27] This is the conceptual role played by the original notion of the atom. One way to describe Goldstein's rejection of the reflex physiology is as a mistaken search for the *atoms of* behaviour, and Goldstein does frequently refer to their experimental methods as "atomistic". Having dropped the atomistic assumption, there is no logic to following experimental procedures that isolate parts in order to observe them independently from their context in the organism, for it is to be expected that *parts behave differently in wholes*. It appears thoroughly wrongheaded to presume that the behaviour observed in simplified experimental contexts will explain what happens with the whole organism, in its natural context. Goldstein writes that,

> Investigations under artificial conditions can never lead to knowledge of *natural* performances. Thus it is impossible to regard the reflexes as unnatural processes, and to assume at the same time that one can obtain from them an insight into the 'natural' performances of the organism.
>
> The fact that the reflex is a process *in* the organism does not mean that it belongs to the real nature of the organism. Reality, in this sense, means that a process belongs to the true 'nature' of the organism. In this light, *'unnatural' and 'unreal'* are the same. (1934/1939, 405)

Here we can read Goldstein as warning us away from a fallacy of misplaced concreteness, in which the "unnatural" and abstract in the sense of being derived from a process of experimental simplification, or "unreal" and ideal – the 'as if' concept of a simple reflex -- are allowed to take the place in our thought of the whole, concrete organism.[28]

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[27] Thus organicism is often depicted as a Heraclitean philosophy. It is therefore to be noted that in an "Excursus" excluded from the English translation of *The Organism*, Parmenides is instead identified as the original proponent of the conception of knowledge advocated by Goldstein (1934/2014, 311-315).

[28] Interestingly, Goldstein's view is that the unreality of abstraction is more tolerable in the physical sciences than in biology.

> "If the reference to the whole is *insufficient, the action may possibly be correct for a part, artificially isolated. But it will distort the functioning of the whole.* Therefore we [biologists] cannot be satisfied with symbols which correspond only to part processes. And therefore we have to reject, for example, the scheme which serves as the basis of reflexology. Our knowledge must come closer to the 'real' than is requisite for a science of inorganic nature." (1934/1939, 412-3)

Goldstein's rejection of the physical-chemical approach to biology becomes apparent in his discussion of the significance of the chemistry of hormones for the biologist. In an argument that is comparable to the passage of Bergson (1907/1944:36 quoted above 2.3), Goldstein declares:

> But do all these amazing facts indicate anything more than that the substance, which has been determined *in an isolating investigation*, is significant for the existence of, and the formation of, a very definite property of the organism? They tell us nothing about the property itself, nor about the life process as a whole. A chemical description will never adequately explain a biological process. (1934/1939, 208; emphasis added)

The rejection of a physical-chemical conception of the organism depends on the argument that isolating experiments performed on parts of organisms are by their nature abstracting, giving "partial views", as Bergson put it. By assembling a collection of such partial views it is impossible to recover the "essence" (Bergson) or "nature" (Goldstein) of the organism. Goldstein differs from Bergson, however, in his belief that the scientific intellect is not confined to the analytical, abstractive frame of mind.

Goldstein's recommendation is that "synthesis", a kind of "Schau" (intuition) is a necessary complement to the analytical mindset that yields "atomizing" experimental science:

> *Biological knowledge is continued creative activity, by which the idea* of *the organism comes increasingly within reach* of *our experience. It is a sort* of *ideation equivalent to* Goethe's "Schau," a procedure which springs continuously from empirical facts and never fails to be grounded in and substantiated by them. (1934/1939, 402)

In addition, Goldstein (e.g. p. 400, 403) emphasizes, that analysis should not ever be dispensed with in spite of his warnings about its limitations. Successful research requires a

Not only must biologists avoid mistaking the abstract for the concrete, avoiding the fallacy of misplaced concreteness, but they also must eschew abstraction more than physicists do.

balanced co-operation of analysis and synthesis.[29] In explaining why it is that this creative, synthetic dimension in biological thought is not a retreat into mysticism, it is quite significant that Goldstein puts himself, the knowing subject and scientist, back into the frame of examination -- for it is the unprincipled ignoring of the scientist's own subjectivity and mindset that Husserl condemns in "objectivizing" science. Goldstein writes that,

> *The attainment* of *biological knowledge* we are seeking is essentially akin to this *phenomenon--to the capacity of the organism to become adequate to its environmental conditions.* This is a fundamental biological process by virtue of which the actualization of organisms is made possible. Whenever we speak of the nature, of the idea, picture, or conception of the organism, we have in mind these essentials for the realization of adequacy between the organism and its environment. And these are the principles of composition of that picture which biology has to grasp. In so doing, the cognitive process of the biologist is subject to practically the same difficulties of procedure as the organism in learning; he has to find the adequacy between concept and reality. (1934/1939, 402-3)

The biologist's quest to attain knowledge is fundamentally no different from any living creature's attempt to come to terms with the world around it. This act may have an element of creativity, but does not require anything supernatural. Goldstein's criticism of mechanistic biology, and any attempt to understand the nervous system by analogy to mechanistic processes and machines, is that it fails to make that leap of imagination that would synthesise isolated empirical observations into a picture of the organism that attains a higher level of knowledge or insight. We will now read Canguilhem (Section 4) and Merleau-Ponty (Section 5) with the critique of abstraction and the influence of Goldstein in mind.

[29] "Scientific research is always founded upon analysis, and, on the other hand, will never proceed without a certain synthesis." (p.404)

4. "What we can learn from the machines is how our brain must differ from them"[30]

The writings of Canguilhem are attracting increasing attention in their own right, not merely as a prelude to the oeuvre of Michel Foucault. Roth (2013) relates in detail the path from Canguilhem's early hostility to Bergsonian philosophy, to an expressed appreciation and debt to Bergson after the late 1930's. Canguilhem's sympathies with vitalism were self-declared, but by "vitalism" he did not mean an ontological commitment to vital forces but a kind of "positivism" that takes the phenomenon of life at face value (Canguilhem 1965/2008a). His admiration for *The Organism* is evident in the introduction to the 1952 collection of essays and lectures *Knowledge of Life* (*La connaissance de la vie)*.[31] Following a quotation from Goldstein, Canguilhem writes that if in doing mathematics, we feel like angels, to do biology we have to feel a little like beasts. One is reminded of Goldstein's contention that biological knowing is an instance of the attainment of adequacy between the (human) organism and the environment. In my reconstruction of an anti-computationalist position in Canguilhem, I will read two texts, "Machine et Organisme" (first presented in 1947), and "The Role of Analogies and Models in Biological Discovery" from 1963.

It was noted in Section 2.1 that Whitehead acknowledged a debt to Bergson's idea that there is a foundational abstraction that defines modern science (i.e. classical physics 17-19th century): the spatialisation of time. In one of his accounts of this distorting abstraction, Bergson describes it as being arrived at by a superficial analogy.

> No question has been more neglected by philosophers than that of time; and yet they all agree in declaring it of capital importance. This is because they begin ranking space with time; then having thoroughly studied the one (generally, space), they leave it to us to treat the other similarly. But we shall not arrive at anything that way. The analogy between time and space is, in fact, wholly external and superficial.

[30] Neurophysiologist Lord Adrian, Quoted approvingly by Canguilhem (1963, 516).

[31] See also Canguilhem (1955/2015, 4 & 164), where he writes approvingly of Merleau-Ponty's uptake of Goldstein in *La structure du comportement.*

> It is the result of our using space to measure and symbolize time. If we are guided by this analogy, therefore, if we are to go looking in time for features like those of space it is at space that we shall stop, at space that covers time and represents it visually for our convenience – we shall not have pushed on to time itself. (Bergson 1922/1999, xxviii)

Here we have the template for *abstraction via analogy*, the framing of the investigation of one order of nature by means of its similarity to a system whose order of relations are better known or more readily comprehended by the scientist. It is an abstraction because the details of the two systems that differ from one another (the *disanalogies*) are put to one side and, as I argue elsewhere, it has practical utility as a simplifying strategy (Chirimuuta forthcoming-b). The danger of falling into a fallacy of misplaced concreteness comes precisely with the habit of neglecting these disanalogies for so long that one forgets that they ever existed. One strand of Canguilhem's writing on the comparison between machines and organisms in the history of science can be taken as a warning against this neglect of difference. Where the more readily comprehended system ("analogue source"[32]) is the man-made machine, and the more epistemically opaque system ("analogue target") is an organism or organ of a body, and where a machine can be made to function almost like that organ, it is easy to forget that there was ever anything more to the organ than the functioning replicated in the machine. When dealing with machines and organisms, not space and time, the analogy is "internal and deep" rather than "external and superficial", heightening the risk of conceptual substitution. Computationalism is precisely the result of this mistaken substitution: cognition – the functioning of the cerebral organ – is taken to be fully captured by machines which bear some analogy to this organ, viz. computers or artificial intelligences.

We will now examine some of the details in Canguilhem's writing that lend themselves to this anti-computationalist argument. Ian Hacking is one prominent philosopher of science who has published on "Machine and Organism". However, his reading is rather fixated on

[32] This terminology is borrowed from Bartha (2016).

the statement that "Machines can be considered organs of the human species." (Canguilhem 1965/2008b, 87),[33] and Hacking takes the anti-Cartesian lesson of the essay to be simply that there is another kind of dualism (organ vs. machine) that needs to be uprooted – thus projecting onto Canguilhem the ideas of Donna Haraway and Andy Clark, on how we are all cyborgs. This misses the way in which Canguilhem's anti-Cartesianism relates to the anti-mechanistic spirit of the organicist philosophy that Canguilhem draws on. Thus Hacking ignores the places in the text in which Canguilhem emphasises the distinguishing characteristics of organisms – their plasticity, unpredictability, and often lack of segregated functional systems.[34] For example, the epigraph to Part I of *Connaissance de la vie*, is a quotation from *L'Évolution Créatrice*, which advises against the presumption that nature works in the way that we would rationally expect things to be done, and hence, by analogy with how we would build a device to work – that is, the expectation based on the use of "pure reason" which is, for Bergson, a capacity always directed at instrumental results. Thus it is helpful to examine various portions of "Machine and Organism" through the Bergsonian lens left unutilized in Hacking's reading.

A large portion of the essay is a reflection on Descartes' invitation, at the start of *Traité de l'homme* (*Treatise on Man*), for us to consider the human body as a statue made by divine hands – greatly more complex and intricate than the moving, hydraulic devices of Descartes' time, but still obeying the same mechanical principles. There is a nested set of

[33] Incidentally, Canguilhem credits Bergson for this insight (1965/2008b, note 64); cf. "ce qui fait, selon nous, la valeur de la philosophie bergsonienne, pourvu toutefois qu'on la lise sans préjugé — ce qui, nous pouvons l'avouer, n'a pas toujours été notre cas — c'est d'avoir compris le rapport exact de l'organisme et du mécanisme, d'avoir été une philosophie biologique du machinisme, traitant les machines comme des organes de la vie, et jetant les bases d'une organologie générale" Canguilhem (1947, 332), quoted in Roth (2013, 628)

[34] E.g. p.90 "An organism thus has greater latitude of action than a machine. It has less purpose and more potentialities. The living organism acts in accordance with empiricism [selon l'empirisme], whereas the machine, which is the product of calculation, verifies the norms of calculation, that is, the rational norms of identity, consistency, and predictability. Life, by contrast, is experience, that is to say, improvisation, the utilization of occurrences; it is an attempt in all directions." (Canguilhem 2008b:90)

analogical relationships that Canguilhem locates in the *Traité:* a statue is an artefact built by humans to have a resemblance to the human body, while the human body is to be understood as if a statue made by God. Crucially, we are told in Canguilhem's exposition the Cartesian machine-organism analogy that any crude, human-made machine is best understood as a finite approximation of a God-made device of infinitely many parts. As Canguilhem writes,

> The Idea of the living, which divine art imitates, is the living thing. And just as a regular polygon is inscribed within a circle, and in order to derive the circle from it, it is necessary to pass through infinity, so the mechanical artifice is inscribed within life, and to derive one from the other, it is necessary to pass through infinity – that is to say, God. (2008b:85)

The metaphor of the chasm between infinity and a finite approximation is used frequently in *L'Évolution Créatrice* to convey the gap between the reality of the living organism and the abstract representations that come of it through the techniques of mechanistic science. For example, Bergson (1907/1944) writes that "life is no more made of physics-chemical elements than a curve is composed of straight lines" (p.35), and that the eye is an "infinitely complex machine" (p.98).

Another Bergsonian theme of "Machine and Organism" is that of the mutual dependency of mechanistic and finalistic approaches to the living world (a pair of approaches that Bergson associates with Leibniz), and their anthropomorphic character. As Bergson (1907/1944, 50) would have it, "[t]he error of radical finalism, as also that of radical mechanism, is to extend too far the application of certain concepts that are natural to our intellect." This is in the background of a central claim of Canguilhem's, that Descartes' mechanistic philosophy never gets us "one step" outside finality because "to explain organs or organisms through mechanical models is to explain the organ using the organ. It is a tautology, basically, because…. machines can be considered organs of the human species" (Canguilhem 2008b, 87). The point concerning the tautological nature of mechanistic explanation can be expressed as follows: if machines are essentially prosthetic extensions of human intentionality, in particular, of the purposeful action that is manifest primarily in

the organs over which we have the most voluntary control – our hands and limbs (see p.94), then machines and mechanisms are themselves full of human intentionality and purpose. It is therefore a (self) deception to attempt to use the analogy between machines and organisms to provide explanations of living organs that purport to have banished all notions of intentionality, purpose and finality. For finalism always accompanies mechanistic explanation, like a lurking Doppelgänger.

This passage may not appear at first glance to contain an argument from abstraction, but it does bear interesting relations to Whitehead's critique of the dualism that results from the Cartesian abstraction that takes mathematized matter, *res extensa,* (what is subject to mechanistic explanation) to be fully distinct from what is mental and volitional, *res cogitans.* For both Canguilhem and Whitehead, Descartes' procedure is to abstract the body machine from the concrete living person, which is to leave a residue that does not have a place in mechanistic explanation, but which persists awkwardly: Whitehead focuses on the mental life (sensations and qualities) divorced from the Cartesian conception of matter, whereas Canguilhem draws attention to the finality that is concealed and deferred through Descartes' picturesque idea of a divinely-made machine. Like Husserl's figure of Galileo, Descartes for Canguilhem is an archetypal "discoverer/concealer" [*Entdecker/Verdecker*] of 17th century natural philosophy. One can also compare Canguilhem's discussion with Husserl's treatment of the Lifeworld as the substrate of meaning on which the scientific edifice is built. One aspect of the meaningfulness or intentionality belonging to the Lifeworld is the purposefulness of organisms as we ordinarily encounter them. This immanent purposefulness is not compatible with the Cartesian conception of matter. But in the Cartesian substitution of the organism for a mere mechanism, Canguilhem tells us, finality cannot really be abolished, and so it is made transcendent, residing with Descartes' divine artificer. This residual finality was supposed to have been rendered superfluous by mechanistic explanation, and yet it lingers at the periphery of scientific consciousness.

In "Machine and Organism" there is a brief remark on cybernetics, to the effect that these self-regulating machines do not close the gap between machines and organisms – there is still a qualitative difference:

> There are doubtless devices that regulate themselves, but these are machines superposed upon machines by man. The construction of servomechanisms or electronic automatons displaces the relationship of man to machine but does not alter its sense. (Canguilhem 1965/2008b, 88)

Canguilhem dwells longer on cybernetics in the 1963 "Analogies" paper. One of the guiding ideas of this work is the observation that in physics the analogical use of mathematical models does not invite one to project the ontology of the analogue-source (e.g. a pendulum described mathematically as a harmonic oscillator) on to the analogue-target (e.g. an electronic oscillator circuit) (Canguilhem 1963, 514-515). In physics it is obvious to the modeller that the use of the harmonic equations in both contexts says nothing about the inherent nature of the two systems related by the analogy -- a caution that is often lacking when such modelling practice is conducted in biology. Canguilhem's point is that the use of a physical system as the source for an analogy to a biological target carries with it a promise of a reduction of the organic to the inorganic – i.e. the making sense of the organic in perspicacious physical terms. This is why the ontological projection of an analogical model onto a living system is tempting. Canguilhem goes on to say that cybernetic models are a good example of this tendency, especially when the model's actions (e.g. in a robot), tends to simulate or mimic a natural behaviour.

> But has it not sometimes happened that the analogical models of the biologist have benefited from an unconscious validation having as its effect the reduction of the organic to its analogy mechanical, physical or chemical? Despite their great degree of mathematical complexity, it does not appear that cybernetic models are always safe from this accident. The magical aspect of simulation is strongly resistant to the exorcism of science. (Canguilhem 1963:514-5)

Canguilhem refers to the well-known cybernetic research of Norbert Wiener and W. Grey Walter. One of the ideas promoted by the cyberneticists was that biological regulation,

which appears intuitively as purposeful control, can be modelled and duplicated with feedback mechanisms, leading to the claim that teleology and purpose in living systems simply *are* feedback (Rosenblueth, Wiener, and Bigelow 1943). Canguilhem rejects this ontological re-characterisation of regulation in organic systems, saying that we should not take feedback models to be representing the "process of nervous regulation". Accordingly, one should be aware that what the model represents is only the structure or set of characteristics common to organic and mechanical regulations (which is "a new class of objects"), and that this abstracts away from the differences between the two kinds of system:

> when one labels as feed-back the parts of the nervous system for which the mechanical mode of regulation serves as a model, one seems to give the impression that organic feed-back is part of the same class of objects as mechanical feed-back. In fact, one has created, by bringing these together, a new class of objects whose definition would be able to retain only the operational characters common to regulator organs and mechanical regulating arrangements. (Canguilhem 1963:515)

For this reason, Canguilhem endorses the warnings made by scientists themselves about the limitations of cybernetic models of the nervous system – "the counsels of prudence that biologists address to each other inside their working community." (p.516) – such as the remark of Adrian (1954, 8, quoted above) and the observations of mathematician John von Neumann on the robustness and plasticity of organisms that is found lacking in computational machines.

The conclusion of the "Analogies" paper is somewhat scathing. Canguilhem says that in the early history of science the "tendency to identify organisms and machines" was "naïve", "magical or puerile." But the latest attempts to build life-like models and machines is no more enlightened, Canguilhem suspects:

> "perhaps a more radical naïveté, an attitude of cognizance, scientific or not, in the face of life, fundamentally inspires new attempts made to exhibit in a model such-or-such organic causalities." (Canguilhem 1963:519)

To confuse the capacities of a cybernetic construction with the nervous system would be no better founded than the mistaking of Vaucanson's duck for one in the pond. But the greater sophistication of cybernetic and computational models, compared to mechanical automata, makes this mistake all the more likely.

5. Merleau-Ponty on the "Absolute Artificialism" of Cybernetics

That Merleau-Ponty was greatly influenced both by Goldstein and Husserl is well documented and uncontroversial. Moran (2012:278-281) notes in particular that Merleau-Ponty began reading Husserl's *Crisis* manuscripts in 1939, and that the impact is strongly felt in Merleau-Ponty's most well-known book, *Phénoménologie de la perception* (Phenomenology of Perception), first published in 1945. *La Structure du Comportement* (*The Structure of Behaviour*), Merleau-Ponty's first book, contains a detailed critique of reflexology, especially as it appears in the work of Sherrington and Pavlov, that is much indebted to Goldstein. In it there are numerous references to *The Organism*, and to Goldstein's joint publications with Adhémar Gelb. Merleau-Ponty is less frequently linked to Bergson and Whitehead than Husserl and Goldstein. However, in the Collège de France course notes on Nature, one finds appreciative exegeses of Bergson (*Matière et mémoire*, as well as *L'Évolution créatrice*) and Whitehead (the 1933 lecture, *Nature and Life*).[35]

In my reconstruction of Merleau-Ponty's abstraction argument against computationalism, I place the *Phenomenology of Perception* at one side and attend more to *The Structure of Behaviour* and the late essay "*L'Œil et l'Esprit*" ("Eye and Mind"), because the former contains the most detailed critique of reflex physiology with its notion that animal behaviour is no more than the operation of a reflex machine, and the latter contains direct criticisms of cybernetics. That is not to say that the content of the *Phenomenology* conflicts with those other works. Indeed, the treatment of the body in Part 1 of that book begins with an attack, recapitulating points from the *Structure*, on the account offered by reflex physiology, both

[35] Incidentally, the lectures on nature are referred to by Canguilhem (1989/2012, 50) in an essay on health.

of behaviour and our "being in the world".[36] Indeed, the project of the *Phenomenology*, to recover for philosophy the world that lies open to us in perception, *presupposes* that we cannot take the world depicted in the abstract and idealised models of science as an absolute, fundamental reality, of greater significance for philosophy than the world of perception – which is of course a message of the critique of abstraction presented in Section 2.[37] Thus we find discussion in the introduction to the *Phenomenology,* of the failure of attempts to establish "an objective science of subjectivity" (Merleau-Ponty 1945/2012, 11), because of reliance on the artificial posit of the discrete sensation. Moreover, overt statements of the critique of abstraction do occur in the *Phenomenology*, such as, "[n]ature *is not* in itself geometrical, it only appears so to a careful observer who limits himself to the macroscopic givens" (Merleau-Ponty 1945/2012, 57) -- that there is something misleading about the geometrization of nature performed in classical physics is of course a recurring motif in the philosophy of Bergson, Whitehead and Husserl.

A striking thesis of the *Structure of Behaviour* is that behaviour resists a settled placement in either one of the two orders of being that our Cartesian scientific heritage presents us with – neither in the external/physical world of matter, nor in the internal/mental realm of intention does behaviour sit well:

> *Behavior*, inasmuch as it has a structure, is not situated in either of these two orders. It does not unfold in objective time and space like a series of physical events; each moment does not occupy one and only one point of time; …… The world, inasmuch as it harbors living beings, ceases to be a material plenum consisting of juxtaposed

[36] "Thus, our 'world' has a particular consistency, relatively independent of stimuli, that forbids treating 'being in the world' as a sum of reflexes" (Merleau-Ponty 1945/2012, 82).

See also, "[Physiology] too begins by situating its object in the world and by treating is [sic] as a fragment of extension. They lose sight of *behavior* by focusing on the reflex…." (Merleau-Ponty 1945/2012, 7).

[37] It also seems that Merleau-Ponty follows Goldstein in attributing the conception, or perception, of something primarily a whole, as being merely an aggregate of abstracted parts, to our employing the "analytical attitude" (1945/2012, 16). See Section 3 on Goldstein's notion of analysis and synthesis in biological thought.

> parts; it opens up at the place where behavior appears. (Merleau-Ponty 1942/1967, 125)

This passage can usefully be read with a glance back to the early 20th century critiques of abstraction. Most striking is Merleau-Ponty's denial that the moments of behaviour occupy discrete moments in time, and that the material world of living beings is a collection of nestled parts. For Bergson, duration is contrasted with the spatialised time of classical physics precisely in its not being thought of as a series of separate moments, like beads on a string. In Whitehead, the distortion introduced by classical physics regarding space – the abstraction of simple spatial location – leads to a conception of the matter contained in it, as comprising innumerable juxtaposed parts that each have a unique location and are not at any fundamental level interconnected with one another. We can interpret Merleau-Ponty also as making a similar point, that the abstractions regarding space and time that founded mathematical physics, and granted it its predictive power, lead us astray when we attempt to account for the bodies and behaviour of organisms.[38]

Indeed, Merleau-Ponty goes on to say that behaviour resists our habitual mode of conceptualising – which would try to fit it into mechanistic terms – even though the phenomenon of behaviour is available to perception:

> The animal, to an extent which varies according to the integration of its behavior, is certainly *another existence*; this existence is perceived by everybody…. Spinoza would not have spent so much time considering a drowning fly if this behaviour had not offered to the eye something other than a fragment of extension; the theory of animal machines is a 'resistance' to the phenomenon of behaviour. Therefore this phenomenon must still be conceptualized. (Merleau-Ponty 1942/1967, 126-7)

To take the mechanistic view of animals is to attempt to locate behaviour within the spatial-temporal abstractions of physical science. According to Merleau-Ponty, the conception of

[38] Compare with the argument in Part 1 of the *Phenomenology* that the body is not an *object,* where object is defined as what "exists *partes extra partes* and thus only admits of external and mechanical relations among its parts or between itself and other objects" (Merleau-Ponty 1945/2012, 75).

animals as machines is just not true to the phenomenon of behaviour, which does not present itself as "a fragment of extension". But if one ignores the phenomena, and settles for the abstract conception of animals as being fleshy machines, one will inevitably believe in the possibility that their organs and capacities are replicable in artificial systems, with a computer being equivalent to a brain. Alternatively, the rejection of the conception of animals as machines entails the rejection of the possibility of manufacturing devices whose operation is perfectly equivalent to their organs, such as intelligent robots. Thus we see that the rejection of computationalism follows directly from Merleau-Ponty's pursuance of the critique of abstraction. In fact, Merleau-Ponty does not just reject computationalism as any other fallacy, but warns that a culture that convinces itself of the truth of computationalism – in its early guise, the "ideology of cybernetics" – is one walking into a "nightmare". We find this arresting claim in the opening section of "Eye and Mind".

In comparison to his 1948 Radio France lectures (Merleau-Ponty 2004), where there is a detectable optimism about the potential of 20th century science (e.g. quantum and relativistic physics) to move beyond the problematic assumptions of classical physics, the assessment of contemporary research to be found in "Eye and Mind" is quite foreboding. Merleau-Ponty shares with Canguilhem (1963) -- and for that matter, with the information theorist Claude Shannon (1956) -- a dim view of practice in biology that grabs haphazardly after any mathematical model that has had one successful application, to see if perchance it will work elsewhere (Merleau-Ponty 1961/2004, 292). This leads, Merleau-Ponty says, to a science of "intellectual fads and fashions" and "[v]agabond endeavours."

The criticism of cybernetics is grounded in a Husserlian concern that science must not forget its starting point in our Lifeworld (the "brute, existent world"), and must not mistake for an absolute and general reality, the operationalised conceptions of its objects, those laboratory constructs that are the result of careful experimental isolation:

> For all its fluency, science must nevertheless understand itself; it must see itself as a construction based on a brute, existent world and not claim for its blind operations that constituting value which 'concepts of nature' were able to have in an idealist

> philosophy. To say that the world is, by nominal definition, the object *x* of our operations is to treat the scientist's knowledge as if it were absolute, as if everything that is and has been was meant only to enter the laboratory. Thinking 'operationally' has become a sort of absolute artificialism, such as we see in the ideology of cybernetics, where human creations are derived from a natural information process, itself conceived on the model of human machines. If this kind of thinking were to extend its reign to man and history; if, pretending to ignore what we know of them through our own situations, it were to set out to construct man and history on the basis of a few abstract indices (as a decadent psychoanalysis and a decadent culturalism have done in the United States) – then, since man really becomes the *manipulandum* he takes himself to be, we enter into a cultural regimen where there is neither truth nor falsity concerning man and history, into a sleep or a nightmare, from which there is no awakening. (Merleau-Ponty 1961/2004, 292)

The "absolute artificialism" of cybernetics is a kind of vicious circularity: the cyberneticist has an understanding of organisms based on selective attention to analogies with machines and then uses this conception of organism to inspire the building of new devices, which are then projected back onto living organisms as models of their workings, and through the cumulative and recurrent effect of this process it becomes impossible to think of the organism – including the human being – in any other terms than as a tool, a thing to be manipulated and an instrument at the service of interminable projects of intervention and control.

These portents at the beginning of "Eye and Mind" are a precursor to the redemptive message to be found in the bulk of the essay, which is that the contemplation of painting is one path back to awareness of the "brute, existent world". This is, in other words, a return to the lived experience of the body. We find in the paragraph following the one quoted above, the recommendation that in order to offset the danger presented by the cybernetic view of humanity, scientific thought must not continue to ignore the subjectivity of the body and its environing world:

> Scientific thinking, a thinking which looks on from above, and thinks of the object-in-general, must return to the 'there is' which underlies it; to the site, the soil of the sensible and opened world such as it is in our life and for our body – not that possible body which we may legitimately think of as an information machine but that actual body I call mine…. (Merleau-Ponty 1961/2004, 292-3)

Thus we see how closely the embodiment/embeddedness argument against computationalism follows from the abstraction argument. Computationalism (or at the time of Merleau-Ponty's writing "Cyberneticism") is an erroneous view of organic behaviour and experience because it remains in the grip of a set of abstractions inherited from classical science since the 17th century -- mechanism and the mathematization of space and time -- which make it impossible for it to properly grasp the phenomenon of sentient behaviour. To return to the body and the Lifeworld is to break the grip of these abstractions and open the door to a different kind of science.

Is 4E cognitive science – the research that is embodied, enactive, embedded and ecological – the different kind of science that Merleau-Ponty envisaged? This is not the place to give a full and proper answer to this question. Not least because 4E cognitive science is a broad church and some of its practitioners may be more sensitive to the concerns expressed by Merleau-Ponty. What I will say is that the element of 4E cognitive science that relies on mathematical modelling, especially dynamical systems theory, to represent the embeddedness ("close coupling") of the mind and its environment, is equally open to the criticisms of abstraction levelled at cybernetics and classical (symbolic) computationalism. As a scientific approach it is just as much abstract,[39] "objectifying" (neglecting the subjectivity both of the scientist and the target of modelling), and physicalistic (since it borrows its mathematical framework from physics) as the research criticised by Canguilhem and Merleau-Ponty. Furthermore, the dynamical systems approach to cognition has at its heart an analogy between organismic cognition and a very

[39] I argue at length elsewhere that the abstractions grounding the dynamical approach in cognitive science are different from and complementary to the abstractions of classical computationalism (Chirimuuta 2020).

simple, mechanistic regulatory device – the Watt governor (van Gelder 1995). All of the concerns about the over-extension of such machine-organism comparisons would apply there.

Thus it strikes me that Merleau-Ponty's pronouncements about embodiment and the embeddedness of thought could not have been so easily assimilated to the 4E tradition had attention been paid to the argument from abstraction that is, I submit, the line of argument that has a philosophical primacy over the turn to embodiment. Yet the version of Merleau-Ponty who tends to be quoted as an inspirational figure for the 4E movement is like the stereotype of a French lover, fixated on the body and sensuality, lyrical and seductive, with his many notions of the pleasures of embodied existence; that Merleau-Ponty was well versed in the experimental psychology and neurobiology of his time also enhances his credentials amongst 4E philosophers of cognitive science. We do not encounter the philosopher ruminating on the dehumanising trend of technological civilisation, and ranking the philosophical significance of art above that of laboratory science. Perhaps this is because the deeper criticisms of Merleau-Ponty, and the philosophers who influenced him, on the role of abstraction in the scientific world view are much harder to reconcile with the technological ambitions of cognitive science in the professional context of today's research university.

6. Conclusions and Directions

It is worth recapitulating the main points of this paper. I argued in Section 2 that philosophy in the first half of the 20th century saw an extensive discussion of the role of abstraction and idealisation of science that did not find its way into the canon of philosophy of science taught to students decades later in the anglophone world. In this discussion we encounter a critique of abstraction that warns philosophers against the reified and over-literal interpretation of scientific concepts and models that are highly simplified and at least somewhat distorted. The critique of abstractions employed within mechanistic strands of biology, such as reflex physiology, played a prominent role in the organicist tradition of biology, exemplified here by the work of Kurt Goldstein. I then argued that Goldstein's

criticisms of the abstractions employed in reflex physiology, and the rejection of the attendant notion that the animal is a reflex machine, are continuous with the criticisms of cybernetics put forward by Canguilhem and Merleau-Ponty. The common claim is that thinking of an animal as a machine, the brain as a computer, is to impose onto the organism a mechanistic schema derived from physics that must deny the existence of features of the living system not shared with the merely physical one, such as the basic interdependency of the parts of the organism, and the explanatory role of the state of the organism as a whole. Furthermore, those research programmes in behavioural physiology, whether they be reflexology or cybernetics, that create the appearance of the descriptive and explanatory adequacy of the machine-organism analogy do so by experimental strictures that limit organismic behaviour to over-simplified and inadequate operationalisations: the abstract model achieves its success when the target of the model – the living system – is itself put in a simplifying frame. This is the "absolute artificialism" of cybernetics.

It should be clear that this abstraction argument generalises to other kinds of computational models of brain processes. Computational models abstract from most of the complexity of the biological brain – its material basis in neural tissue, its situation in a body, its interaction with other organismic processes such as those of the endocrine and immune systems. Computationalism in the philosophy of mind contends that cognition in animals is fully reproducible in a non-living computational machine, sharing only "functional equivalence" with the "wetware" running in the brain. The abstraction argument against computationalism has it that the computationalist is too incautious in her reading of lessons about the nature of the minds of humans and other animals from any computational model of their brains and behaviour, because the model's judicious neglect of biological complexity is likely to make it miss the hard-to-duplicate features of organic cognition that we care most about – sentience, flexibility, common-sense, a sense of being in the world. Just because the abstraction to computational description of neural systems is useful for building specialist AI programs that duplicate certain cognitive tasks, it should not be assumed that computation is the essence of cognition, or that building AI expert systems

is a step along the road to the explanation of general intelligence – the kind of intelligence possessed by humans and other animals.

In this paper I have argued that the philosophy of science behind the embedded/embodied cognition stance favoured in the 4E tradition has been unduly neglected. It also deserves mention that there is a political background to the argument against the identification of organisms with machines, at least as it appears in the discussion of Canguilhem. As Canguilhem relates, drawing on the book *Machinisme et Philosophie* by Pierre-Maxime Schuhl, slaves were animate machines for Aristotle – the original machines, he asserts, were humans marked out for exploitation.[40] For Canguilhem, there is no way to separate the concept of mechanism from that of exploitable labour and resource:

> Descartes does to the animal what Aristotle did to the slave: he devalorizes it in order to justify its use by man as an instrument.

Furthermore,

> The theoretical mechanization of life and the technical utilization of the animal are inseparable. Man can make himself master and possessor of nature only if he denies all natural purpose and can consider all of nature, including, apparently, animate nature – except for himself – to be a means.
>
> This is what legitimates the construction of a mechanical model of the living body, including the human body… (1965/2008b, 84)

Given that historians of science have already begun to trace the relationship between the invention of computers and industrialisation (Schaffer 1994), cybernetics and cold-war politics (Galison 1994), there remains an important task, which is to find out whether the arguments put forward by Merleau-Ponty against computationalism and for embodied and

[40] E.g. p.18-19 "Ces considérations permettent de préciser quelle portée il faut attribuer au passage célèbre du début de *la Politique* où Aristote declare que l'esclavage cesserait d'être nécessaire si les navettes et les plectres pouvaient se mettre en movement d'eux-mêmes: l'idée s'accorde à merveille avec sa definition de l'esclave, instrument animé. Est-ce là, chez le Stagirite, une divination, une prévision de l'industrie modern?" (Schuhl 1938, 18-19)

embedded cognition, rest also on a political philosophy. If so, it would turn out that the 4E programme has a forgotten politics, just as I have shown it to depend on a neglected philosophy of science.

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